

Natural Gas Industry in Korea: Current Status and Outlook

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Abstract

Korea's natural gas industry has a relatively short history, but it has displayed a dynamic growth and this growth will continue in the foreseeable future. The use of natural gas has been promoted due to the government policy to diversify the energy source to lower dependency on oil and to regulate air pollution, combined with consumers' preference for high grade energy.

The structural change in Korea's energy use and supply, brought about by the growth of natural gas market in Korea, is of main interest of this paper.

Particular focus is given to the rapid increase in gas demand and Korea's nationwide gas supply plan according to which massive facility construction projects have been undertaken.

The Korea Gas Corporation (Kogas) is currently conducting projects for expanding its existing facilities and for building new ones. These include: building more LNG storage tanks, constructing a new LNG receiving terminal, and extending pipelines to form a nationwide transmission network. Attention is paid also to the reform of gas pricing mechanism in Korea so that it would provide with appropriate means for achieving various policy objectives of the government.

I. Introduction

Although the primary energy policy concern of the energy consuming nations in the 1970s and early 1980s had been security of supply, increasing attention has been paid to environmental considerations since then. Presently, the foremost fac-

tor to be considered when formulating any global energy model is the environmental impact of the energy balance.

Recently, ministers from the member nations comprising the International Energy Agency (IEA) reaffirmed their governments' commitment to develop integrated policies with the aim of energy security, environmental and economic growth. This commitment is well addressed in the "Shared Goals" adopted by IEA Ministers at their 4 June 1993 meeting in Paris, and the goals read:

- diversity, efficiency and flexibility within the energy sector
- the ability to respond promptly and flexibly to energy emergencies
- environmentally sustainable provision and use of energy
- more environmentally acceptable energy sources
- improved energy efficiency
- R&D and market deployment of new and improved energy technologies
- undistorted energy prices
- free and open trade
- cooperation among energy market participants

Natural gas is regarded by many as a fuel which meets many of the key requirements for being the choice of today's energy source. Major usage of natural gas in the world are: 1) for public consumption - for space and water heating and cooking in residential and commercial outlets; 2) for power generation—as an under-boiler fuel for baseload power plants and increasingly, for combined-cycle and cogeneration power plants; 3) for petrochemicals industry—for the manufacture of ammonia for fertilizers and methanol. The size and relative importance of these markets can vary significantly from country to country, depending on such factors as the availability of gas supply sources, the stage of development of the gas industry, its infrastructure, and the competitive position of gas relative to other fuels.

Natural gas has only recently arrived to the Korea's energy scene. Although city gas, supplied with manufactured gas, was introduced in small amounts as early as in 1972, it was not until 1986, when liquefied natural gas was first imported, that gas consumption started to grow significantly. City gas in Korea was initially made from a mixture of naphtha, propane and butane. The use of butane was phased out by 1983 as was naphtha by 1991. As pipelines which transmit natural gas are extended, more and more of propane-based city gas distribution is being replaced by natural gas supply.

Korea has been constructing the nationwide natural gas transmission network which will cover most of the nation's territory as its supply zones for natural gas transportation. By 2000, when the network is completed, the nation will see that almost all city gas distribution is converted to natural gas distribution. This conversion to natural gas will be the main factor in the acceleration of natural gas

demand increase in Korea around the end of the century.

As mentioned, Korea's natural gas industry is very young, with less than 10 years of supply experience, and is still at an early development stage. But it has displayed a dynamic growth both in its size and in its role as an important energy sector in the nation.

The industry's rapid growth will continue in the foreseeable future. A demand forecast recently announced by the Korean government and the Korea Gas Corporation (Kogas) predicts that the nation's natural gas consumption will be doubled in three years, and 2.5 times by the year 2000 compared to the '93 level which was about 4.6 million tonnes.

There are reasons for the growth prospects of natural gas supply and demand, that are usually associated with economic and environmental rationale. This reasoning and some details on Korean gas market are reviewed in the following sections.

II. Global Issues for Natural Gas Industry

Many factors have to be taken into account when reviewing energy-related problems. Some of them are situations and perspectives on: population growth; quality of services which energy provides (heating, cooling, cooking, motive power, etc.) and ease of handling the fuel; efficiency in energy provision and utilization; encouragement of energy conservation; technological innovation and diffusion potential; development of institutions and capital markets to provide financing; energy pricing policies; and environmental concerns.

The World Energy Council (WEC) developed alternative cases in 1993 to illustrate energy demand prospects. Four cases were chosen for the period to 2020. They are formed as combinations of economic and technological factors. In terms of economic growth, high growth rate represent 3.8% per year, and moderate growth rate represents 3.3% per year. The four cases may be named: a) High growth/High technology; b) Moderate growth/moderate technology; c) Moderate growth/High technology; and d) Moderate growth/Very high technology.

The technology item consists energy intensity reduction, technology transfer and institutional improvements. The total prospects of possible total energy demand in 2020 range from 11.3 to 17.2 Gtoe. <Table 1> presents the outlook classified by fuel type.

From table 1, it is noted that natural gas adds significant portions to overall energy supply in each of the four cases to 2020. The assessment also indicates that the prospective global energy demand is to continue growing at an average rate of around 2% per year. This rate is about the same as that since the oil shock of 1973 but only half the rate of the period until 1974 after 1945.

<Table 1> Global Fuel Consumption Outlook

(Gtoe)

	1960	1990	in 2020			
			A	B	C	D
Coal	1.4	2.3	4.9	3.8	3.0	2.1
Oil	1.0	2.8	4.6	4.5	3.8	2.9
Natural Gas	0.4	1.7	3.6	3.6	3.0	2.5
Nuclear	-	0.4	1.0	1.0	0.8	0.7
Large Hydro	0.15	0.5	1.0	1.0	0.9	0.7
Traditional	0.5	0.9	1.3	1.3	1.3	1.1
New Renewables	-	0.2	0.8	0.8	0.6	1.3
Total	3.3	8.8	17.2	16.0	13.4	11.3

Source: Energy for Tomorrow's World 1993, WEC

<Table 2> World Consumption of Natural Gas by Sector

mtoe (%)

	1985	1990	1995	2000
Self consumption	207 (14)	268 (16)	313 (16)	355 (17)
Electricity generation	337 (23)	383 (22)	413 (21)	434 (20)
Chemical feedstock	95 (6)	127 (7)	146 (8)	163 (8)
Industrial	435 (30)	506 (29)	573 (29)	629 (30)
Residential/Commercial	369 (25)	414 (24)	455 (24)	493 (23)
Other uses	32 (2)	34 (2)	36 (2)	39 (2)

Source: Association Technique de l'Industrie du Gaz en France

Two factors are identified in the assessment as key driving forces of the natural gas growth in future. The first factor is the development of new and fast-growing markets in developing countries. Developing countries are seen also as the major energy growth markets with substantial increases in commercial use and passenger, transportation. The second factor, which will stimulate the gas industry, is the electric power generation sector with world requirements for electricity increasing rapidly. Indeed, almost half of the demand growth envisaged for natural gas is accounted for by this sector. These global energy trends will likely affect energy situation and the process of energy policy making in Korea.

<Table 2> shows the outlook on the world consumption of natural gas assessed by sector. As time goes, and new uses for natural gas are advanced, traditional forms of gas use, i.e. electricity generation and residential/commercial, are expected to yield their incremental shares gradually to new forms of use.

In the global sense, natural gas supplies are believed to be more assured than those of oil. In the same way as the fact that oil has disproportionate share of deposits in the Middle East has been a concern, enormous reserves of natural gas that 'are found in Russia has been a somewhat dubious source of supply. But the disintegration of the USSR and the need for foreign currency in former Soviet Union makes the new confederation a more reliable trading partner than cash-rich Middle Eastern countries threatened by radical religious and political movements. Also, the level of world gas reserves have been trending upward. Since 1989, discoveries of natural gas have outpaced those of oil. For instance, in 1992 proven gas reserves increased approximately 11.5% while those of oil increased less than 1%. Hence the R/P ratio of gas has been rising but that of oil has remained relatively stagnant.

Contingent actions must be developed through close examinations of regional natural gas security issues and assessment of their possible outcomes and long term impact, if any, on market development. One possibility is to encourage development of pipeline gas supplies from Russia, for example, from Sakhaline, Yakutsk or possibly even further afield to the markets of Japan, Korea and Taiwan, currently supplied by LNG, and also to the prospective new markets opening in South China and elsewhere in the region. To apply the same logic to Europe, a study can be made focusing attention more sharply on the benefits of improving conditions for foreign investment in Russian gas supply infrastructure for West Europe, already a key objective of the Energy Charter. Creation of a stable and legal environment for investment are important aspects of this work.

III. Korea's Energy Situation and Policy

1. Energy situation

Energy demand in Korea has increased rapidly from the second half of the 1980's. In particular, it began to increase faster than the economic growth from 1989 to 1992. Such a high increase in energy demand was mainly due to the expansion of energy intensive industries such as petrochemicals and steel industries, factory automation, and the increased numbers of motor vehicles and of buildings. For the period of 1983-93, the annual growth rate of energy consumption averaged at 9.8 percent which was much higher than the average economic growth rate of around over 4 per cent for the same period.

The pattern of fuel use has also changed. This structural change reflects the change in the economy of the country from a largely agrarian one to an industrialized one. In early 1960's, more than 45 percent of total primary energy consumption was made up by firewood. Now this takes less than one percent share of the

total energy consumption. In 1993, the shares of major fuels of total primary energy consumption were: oil 62.1 percent, coal 20 percent, nuclear power 11.5 percent, natural gas 4.5 percent, and hydro power 1.2 percent.

World average of the shares of these fuels in 1993 are approximately: oil 40.0, coal 27.4, natural gas 22.9, nuclear power 7.1 and hydro power 2.5 percent. Comparing the Korean fuel shares with the world average, two patterns are very close except oil and natural gas, the former being main energy source and the latter a new participant in the energy market in Korea.

In terms of per capita energy consumption, Korea's energy demand level is relatively far below those of the developed countries. To compare with a few other countries, per capita energy consumption in Korea was recorded 2.9 toe in 1993, while that in the United States was 7.9 toe in 1988, 3.3 toe in Japan, 3.6 toe in Singapore, and 4.4 toe in Germany.

Unfortunately, however, Korea possesses very low potential of indigenous energy resources, and is producing no oil and gas on its territory. Korea's energy import dependence ratio is very high, reaching up to 94.6 percent in 1993, and is expected to continue to increase in future. Korea paid U.S. \$14.9 billion for energy import in 1993, which is equivalent to 17.8 percent of Korea's total imports.

2. Energy outlook

Due primarily to the government's policy of lowering Korea's dependence on oil and its move towards increased use of gas as a fuel for power generation for environmental reasons, the increase in gas consumption is expected to continue over the foreseeable future. As seen previously, the share of natural gas out of total primary energy supply is forecast to grow from just over 3 mtoe (or about 3.2 percent of total primary energy) in 1990 to just under 22 mtoe (about 10 percent of total primary energy) in 2010.

According to the projection by the Korean Energy Economics Institute (KEEI), total primary energy consumption is forecast to be increasing from the current 103 million toe to 178 million toe in 2000, and to 253 million toe in 2010. This projection reflects the KEEI's assumptions on economic growth, population and the intensity of energy consumption. Ranges for the rates of changes in these parameters which are applied in a manner of gradual change are: 7.0-4.5 percent for economic growth, 0.9-0.1 percent for population increase, 2.2-5.0 toe per person for energy intensity.

3. Energy policy

Energy security is the primary concern of energy policy in Korea. The energy sources have become more diversified for the last decade. In order to meet increased demands for electricity and natural gas, the plans for nuclear generation and coal-fired power plants are promoted; and the construction of additional LNG receiving terminals and nation-wide pipeline networks are currently carried out and planned.

Environmental concern is also emphasized in Korean energy policy. For instance, from January 1993, sale of leaded gasoline was banned, and use of lower sulphur content B-C oil (1.0 percent below) was mandated for the Seoul metropolitan area from July 1993. This environmental policy has underpinned rapid growth in LNG consumption in Korea.

In 1993, the newly elected Korean government established the New Economic Five-Year Plan. The plan, in principle, aims at reforming the economy by emphasizing deregulation/decontrol, strengthening free market mechanism, promoting private sector's participation, and institutional reordering. The major objectives of energy policy shown in the Plan are as follows:

- (1) Reformulating the long term energy supply and demand strategy to develop a sustainable structure for desirable energy / environment / economy in future.
- (2) Strengthening energy conservation measure to construct the more energy efficient economic and social structures.
- (3) Promoting energy related technology R&D activities, and
- (4) Improving the market efficiency through promoting the competitive market mechanism, decentralizing and liberalizing the energy sector.

For the purpose of enhancing the nation's industrial competitiveness on international market, the Korean government decided recently to chart out a set of comprehensive plans, designed to help Korea better face the challenges of freer and more open trade after the expected launching of the World Trade Organization on January 1, 1995.

IV. Korea's Natural Gas Industry

1. Natural gas market

The supply process of natural gas in the Korean market is vertically divided into two stages by distinct business activities: the whole-sale and the retail businesses.

The whole-sale business is responsible for securing gas resources for future importation, contract negotiations, importing, vaporizing and delivering gas to the

retailers or power plants. Korea Gas Corporation (Kogas), the state-run gas supplier has been the monopoly firm for the whole-sale stage of the industry.

The Kogas also builds and operates transmission pipeline network, which works at high pressures up to 70 bars. Under the Korea Gas Corporation Act 1982, the Kogas falls under the reign of the Minister of Trade, Industry and Energy and is permitted to import LNG into the country. It operates the LNG terminal and transport the gas to the Korea Electric Power Corporation (Kepeco), for use in power generation, and to town gas companies who market it to private consumers.

The retail business refers particularly to the gas distribution process carried out by the private sector city gas companies. These retailers are franchised for specific distribution area by the provincial government and there is no competition between companies. They receive the supply of natural gas from the Kogas' transmission pipes, then sell it to end-users through their own low-pressured distribution networks.

Imported LNG is treated for storage and vaporization at the Pyongtaek LNG import terminal, then sent out through the 590 km transmission network covering the Seoul metropolitan area and parts of its vicinity, and in turn delivered through local distribution networks to consumers. At the moment, nine local companies are involved in the retail process. Sixteen other town gas companies that are currently selling gases made of propane are likely to be converted to natural gas distributors as Kogas' transmission line reaches their franchised distribution areas.

While not directly involved in the business of gas distribution, there are 15 private companies that are manufacturing and selling gas appliances. Daesung, Lotte and Rinnai are some of well known gas burner makers among them. As of 1993, there are twenty-nine city gas distribution companies in Korea, and ten of them are currently distributing natural gas transmitted by the Kogas. The rests are waiting for the transmission pipeline to reach their franchised distribution area, so that they will be able to convert to natural gas from the prevailing propane-air gas.

2. Natural Gas Consumption

The initial LNG contract to bring natural gas into Korea had been based on a 2 million tonnes-per-year long term purchase schedule. Because of the rigid supply process of LNG projects, the amount of total natural gas consumption had to be truncated to that import volume level for the first few years of natural gas use. However, as the demand for the city gas from natural gas kicked off and went up rapidly, total consumption started to grow accordingly. The records of Korea's natural gas consumption by user sector are summarized in <Table 3>.

Consequently, not only has the number of households connected to the town gas supply risen drastically but the average annual consumption per household

<Table 3> Natural Gas Consumption in Korea

Unit: thousand tonnes LNG

Year	'87	'88	'89	'90	'91	'92	'93
Power generation	1,537	1,888	1,648	1,719	1,780	2,225	2,524
Industrial	27	50	69	104	133	170	226
Commercial	11	52	148	227	290	352	453
Residential	37	82	132	245	456	734	1,162
Total	1,612	2,072	1,997	2,295	2,659	3,481	4,365

Note: LNG density 456 kg/m³, C.V. 10,500 Kcal/Nm³

has risen steadily, increasing from around 210 cubic meters per household in 1985 to 790 cubic meters per household in 1990.

A few things have provided the main impetus for the government to promote the use of gas in Korea. The most important was the second oil crisis in 1979, which forced the government to reduce the country's high rate of dependence on oil by diversifying sources of energy. The use of gas has also been promoted by the government as a mean for achieving environmental policy objectives, including the regulation of air-pollutants.

For seven years of natural gas supply, down to the end of 1993, natural gas consumption for residential heating has on average more than doubled each year, and the use for power generation has also increased by the rising consumption of electric power.

A. Residential and Commercial Sector

The demand for city gas alone has risen by about 70 percent on an annual average. The substitution of gas for fuels such as briquette for heating and cooking has been seen as an effective way of reducing air pollution in the densely populated urban areas. Therefore, the rapid growth in the demand for city gas for residential and commercial uses has been at the expense of demand for fuels which are seen by consumers as being of inferior quality, such as anthracite and firewood.

Consequently, not only has the number of households connected to the city gas supply risen drastically but the average annual consumption of a household has increased steadily. In 1993 the Seoul-Incheon metropolitan area used 90 percent of all city gas supplies while 10 percent was used in Daejeon city area after the transmission pipeline reached this city, some 170 km south of Seoul, in July 1993. In recent years the major increase in city gas consumption has come from commercial enterprises and large office buildings and apartments.

Kogas sales are lowest in July and August, the hottest months of the year when

there is least demand for gas particularly from residential users. The main variation in seasonal demand is caused by the greater use of gas in winter for space heating. Gas use for power generation does not show such seasonal fluctuation.

B. Power Generation Sector

In Korea, the power generation sector has been a significant user of gas from LNG, but the industry sector has not played a major role. In fact, at the early stage of the development of the natural gas supply industry, the electricity generation sector was an easy solution for using up the contract volume for import.

But, more recent increase in LNG based generating capacity comes from specific plans regarding new utility installations. For instance, of the Korea Electric Power Company's (Kepco) newly added capacities, most of 1992 and about half of 1993 additions were gas-firing power stations, built in five different places. These five new gas-firing utilities were built to supply several new satellite towns surrounding Seoul.

In the late 1980's, being challenged by possible power shortages, Kepco decided to go for the gas firing option as a way to increase power supplies to the newly expanding urban areas in short time. This was to take advantage of the shorter time needed for construction although LNG was more expensive than coal or nuclear power. Also affected the selection was the government's environmental policy: strengthened environmental protection regulations require the use of a clean fuel such as natural gas at new power stations built near densely populated areas.

Kepco's long term power supply plans call for more gas-fired combined cycle utilities. Ever more gas-firing power plants can possibly be brought into the scheme should Kepco encounter excessive problems in the course of pursuing its ambitious electricity development program dominated by coal and nuclear power.

C. Industrial Sector

Gas demand for industrial consumption has been low compared to the use for residential and other purposes. But, the industry sector has displayed a steady increase in gas use. Manufacturing, automobile, printing industries are important users. Base metals, non-metallic minerals and chemical industry are those with greater potential for further consumption of natural gas in Korea. The sector takes a 5 percent share of the total natural gas consumption.

Cold energy from the low temperature of LNG has been utilized since 1990 in the cryogenic air separation plant of Seoul Cryogenic Industry Co. Ltd, located near the Pyongtaek LNG receiving terminal of Kogas. This plant produces liquefied oxygen, liquefied nitrogen and liquefied argon. The company is known to have been saving about U.S. \$1.8 million worth of energy cost annually. The

Kogas also has plans for cryogenic energy projects of its own, and has conducted a couple of feasibility studies for projects such as cold power generation and cold storage.

3. Natural Gas Demand Outlook

Korea is continuing with the construction of the nationwide transmission network for natural gas transportation covering most of the nation's territory as its supply zones. By 2000, when the network is completed, the nation will see that almost all city gas distribution is provided with natural gas. This conversion to natural gas will be the main cause of the acceleration of growth in natural gas consumption during the remaining years of the century.

In 1993, the Ministry of Trade, Industry and Energy (MOTIE) and the Kogas worked for the revision of existing forecasts for gas demand in Korea. The new forecasts for natural gas demand announced in december 1993 can be summarized as shown in table 4. According to the forecast shown as base case projection in <Table 4>, natural gas demand is expected to grow up to 8.9 million tonnes in 1996 and 11.6 million tonnes in 2000, then to 15.5 million tonnes in 2006.

The base case projection represents the compromised results of current trends in town gas consumption and the technical allownaces for the construction periods of planned gas-fired plants. The high and low case projections then represent the progressive and conservation estimates, respectively, for each period.

<Table 5> shows the detail figures of the base case projection. According to <Table 5>, the demand share of town gas will become greater than the share of power generation supply for the first time in 1995. Industrial use of natural gas is expected to grow fast due to the increasing government control of air pollution.

The growth rate over the period for the forecast will gradually decrease as the industry become more matured. Overall, the average growth rate for the period 1993-2006 has been predicted to be 11.2%.

<Table 4> Natural Gas Demand Outlook

Unit: thousand tonnes LNG

	1993 Record	1996	2000	2006
Base case projection	4,365	8,909	11,596	15,484
Low case demand	4,365	8,726	11,307	14,924
High case demand	4,365	9,091	12,335	17,395

Source: MOTIE & Kogas, Long-term Plan for Natural Gas Supply/Demand, Dec. 1993.

<Table 5> Base Case Projections

Unit: thousand tonnes LNG

Year	Town Gas				Power Generation	Total
	Residential	Commercial	Industrial	Sub-total		
'94	1,478	678	256	2,412	2,905	5,317
'95	1,978	892	351	3,221	3,113	6,334
'96	2,604	1,051	480	4,135	4,774	8,909
'97	3,104	1,207	635	4,946	4,720	9,666
'98	3,493	1,336	725	5,554	4,503	10,057
'99	3,871	1,435	796	6,102	4,765	10,867
'00	4,239	1,535	861	6,635	4,961	11,596
'01	4,582	1,649	923	7,154	4,981	12,135
'02	4,868	1,746	974	7,588	5,341	12,929
'03	5,163	1,834	1,035	8,032	5,583	13,615
'04	5,447	1,912	1,091	8,450	5,763	14,213
'05	5,707	1,984	1,146	8,837	6,029	14,866
'06	5,950	2,054	1,201	9,205	6,279	15,484
Growth Rate						
'93-'96	37.2	31.5	29.6	34.7	21.0	26.5
'97-'01	12.0	9.4	14.0	11.6	0.9	6.4
'02-'06	5.4	4.5	5.4	6.8	4.7	5.0
'93-'06	16.1	13.4	15.0	15.3	7.7	11.2

Source: MOTIE & Kogas, Long-term Plan for Natural Gas Supply/Demand, Dec. 1993

4. Infrastructure and Facility Reinforcement

Construction of the first LNG receiving terminal at Pyongtaek and the distribution network for metropolitan Seoul commenced in 1983. The Pyongtaek facility has the capacity to let in 3 million tonnes of LNG a year. At present, the Kogas has one LNG receiving terminal with five storage tanks operating. The capacity of each tank is 100 thousand-cubic-meters. The company is experiencing difficulties in expanding the supply facility to suffice for the fast growing consumption.

In order to be capable of handling the projected base case long-term demands for natural gas, Kogas has put in implementation programs for the expansion of existing facilities as well as for the construction of new facilities. These programs are designed on the grounds that flexible measures should be established to cope with the incremental growths of demand. Thus, the projects include plans to

increase the storage and vaporizing facilities to meet the peak demand and to construct a transmission loop for the purpose of emergency service at distant area, as well as to extend transmission lines to form a nationwide transmission network.

The Pyongtaek LNG terminal, which has 5 storage tanks, is being expanded by adding the 6th storage tank, to be completed by the end of 1994, and another by the end of 1995, by which time the terminal will become capable of handling about 6.6 million tonnes a year. LNG terminal expansion projects are outlined in <Table 6>.

These projects are designed on the grounds that flexible measures should be established to cope with the incremental growths of demand. Thus, the projects include plans to increase the storage and vaporizing facilities to meet the peak demand and to construct a transmission loop for the purpose of emergency service at distant area, as well as to extend transmission lines to form a nationwide transmission network. Concepts behind the plan for the LNG receiving terminal construction includes:

- 1) to increase storage capacity (from 10 times daily supply rate to → 20 times);
- 2) to secure at least 25% of reserved vaporizing facilities;
- 3) to construct the third terminal in order to reinforce the loop function of the transmission network and to meet more effectively the regional gas demand of southern provinces; and
- 4) to design the site layout taking into account the construction of LNG combined cycle power plant on the same site.

The expansion will continue until the terminal has one more berth with the same handling capacity as the existing one and seven more storage tanks by 2006, by which there will be two berths equipped with thirteen storage tanks in all.

A second LNG receiving terminal, is under construction in Incheon at a site

<Table 6> Plan for LNG Terminal Capacity Expansion

Description \ Year	1992	1994	1996	1998	2000	2003	2006
LNG Handling Capacity							
(1000 tonnes/year) at:							
Pyongtaek terminal	3,000	4,000	6,000	6,000	6,000	6,000	6,000
Inchon terminal	-	-	1,500	3,000	4,000	5,000	5,000
Third terminal	-	-	-	-	-	1,500	3,000
Total	3,000	4,000	7,000	9,000	10,000	12,500	14,000
Vaporizing & Pumping Capacity (tonner/hour)							
	1,126	1,746	3,180	3,660	4,570	5,440	6,180

Source: Kogas

<Table 7> Facility Reinforcement Plan

Description		'94-'96	'97-'00	'01-'06
Tanks	New	5	12	9
	Total	(10)	(22)	(31)
Berths	New	1	3	1
	Total	(2)	(5)	(6)
Transmission Line	New	1,065 Km	1,376 Km	
	Total	(1,593 Km)	(1,904 Km)	

Source: Kogas

located south of Incheon harbours, near to Incheon power station, one of Kogas' largest customers at present. This terminal will have three storage tanks by 1996 and twelve tanks by 2006.

The total length of the current (end of 1993) transmission pipeline is 590 km, to which three operating pressure levels are applied. The total length can also be divided into 450 km of main lines and 145 km of branch lines.

Plan for the extension of the nationwide transmission pipeline consists of two-phases: 1) the Phase I (until 1996) is an accelerated construction plan to form an overall framework of the transmission pipeline, while in the meantime connecting major urban areas alongside its paths, and 2) the Phase II is the follow-up construction plan which will succeed the Phase I, and connect less populated and remote areas. The Phase I aims to build a total of 1,593 km (mains 1,385 and branches 208) during 1994-96 period, and the Phase II will add a total of 1,904 km (mains 1,585 and branches 319) during 1997-2000. By the year 2000, when the nationwide transmission network is completed, virtually all of piped gas distribution will come from natural gas.

<Table 8> Funds Requirement

Description	'90-'94	'95-'00	Total	Unit: \$ million
				(%)
Terminals:				
Pyongtaek	241	-	241	(9.6)
Inchon	381	413	794	(3.16)
Sub-total	622	413	1,035	(41.2)
Transmission Pipelines	1,078	399	1,477	(58.8)
Total	1,700	812	2,512	(100.0)

As a follow-up project to the formation of the nationwide transmission network, a plan for building a third receiving terminal with six storage tanks has been under close review. The need for the third terminal is centered around the optimal location of supply point in view of enhancing the effectiveness of the enlarged transmission network, which will be covering most of the nation's land including the southern provinces and townships. Although the location for the site has not been determined, the plan calls for its storage tanks to be built and be operative by 2006. Total numbers for tanks and berths by 2006 will be as shown in <Table 7>.

When these plans have been completed in success, Korea will have a total of 31 storage tanks operative by 2006, the planning period of the above mentioned outlook for natural gas supply/demand.

Funds required for investment in these programs amount to 2.5 billion dollars: 1.0 billion dollars for terminal construction and 1.5 billion dollars for main trunk line construction. This is shown in <Table 8>.

5. LNG Importation and Supply

The first long-term (20 years) contract for the procurement of LNG to be imported to Korea was signed in August 1983 with Pertamina of Indonesia. It was for the importation of 2 million tonnes of LNG annually over the period 1986-2006. A further contract for an additional 2 million tonnes of LNG a year from Indonesia over the period 1994-2014 has been signed afterwards. In addition, Korea signed a contract to import another 2 million tonnes of LNG a year from Malaysia over the period 1995-2015. Price terms for the first contract is based on CIF, while the latter two contracts are based on FOB.

The Kogas has also been active in the spot LNG market, purchasing 0.5 million tonnes in 1992 and 1.08 million tonnes for 1993 from Indonesia. These spot purchases were required to keep up with the extra demand for town gas which was increasing at a pace well above the earlier predictions.

Import from Malaysia began in 1991 bringing 58 thousand tonnes initially, and the amount has steadily increased to 290 thousand tonnes in 1993. Australia and Brunei have recently been added to the list of Kogas's import sources. <Table 9> shows Korea's LNG import for each year since the first import in 1986.

Regarding the origin of imports, the government's policy is to diversify source for LNG. The long-term guideline is that it should not rely on anyone country for more than 40 percent of the nation's LNG supplies. Korea is also pursuing a policy to participate in the development of overseas gas fields with the goal of owing about 15 percent of future LNG imports. The Kogas wants to achieve a combination of short and long-term contracts for securing volumes further required to

<Table 9> LNG Imports

Unit: thousand tonnes LNG

Orijin \ Year	'86	'87	'88	'89	'90	'91	'92	'93
Indonesia	117	1,682	2,063	2,014	2,291	2,642	3,191	3,762
Malaysia						58	117	290
Australia								56
Total	117	1,682	2,063	2,014	2,291	2,700	3,308	4,108

Source: Kogas

import. Presently, the company considers that an appropriate mix of import contracts would be 65 percent long term contracts and 20 percent short term contracts.

No one is allowed to import LNG into the country without a Minister's licence. Before obtaining a licence, the prospective importer is required to get approval of the MOTIE on the terms of the LNG importation contract, namely the price and the volume. At present only the Kogas has been granted a licence to import LNG. In the future, however, other companies may wish to take part in importing LNG and seek a licence to import LNG. For example, Kepco or some future private power generation companies may wish to import their own LNG for direct use in power generation. The economic viability of such imports will depend upon the level of demand.

The first significant imports of LNG were made in 1987. In that year 1.7 million tonnes of LNG were imported from Indonesia. In 1993, the total annual imports reached 4.1 million tons, or about 4.5 percent of total primary energy consumption. The majority of the imported LNG has been used for power generation. However, the share of LNG being distributed to end users as town gas has increased steadily from about 5 percent in 1987 to over 42 percent in 1993.

Among other possible supply sources that are under review are: the No. 3 LNG project in Malaysia and projects in Brunei, Australia, Sakhalin, Yemen and Indonesia. All these alternative sources are in connection with our efforts to secure as well as to diversify import sources.

In line with the growing amount of gas imports, Korea's shipping and ship building industries are eagerly participating in a campaign to transport LNG using Korean-owned ships. Four such LNG tankers are being built at present and companies who will be operating the actual shipping work have been selected. In July 1994, LNG transportation by the first Korean tanker started.

6. Natural Gas Pricing

Gas pricing has been the Korean government's main mechanism for promoting the consumption of gas by way of regulating the price of natural gas to ensure that it remains an economically attractive fuel. Prices are determined by the government based on:

- 1) LNG purchase and importation costs—these make up approximately 70 percent of the final cost of gas and 54 percent of consumer rate.
- 2) Kogas' supply costs—these include the cost of pipeline transportation of the gas, depreciation, administration and maintenance costs. The government allows to include an appropriate rate of return for the Kogas' investment. This generally amounts to 10-14 percent, depending on financial market environment.
- 3) VAT at 10 percent, and a customs tariff of 1 percent; and
- 4) City gas company's distribution costs, including a return on investments made by gas companies. This makes up about 25% of consumer price

Under the existing pricing mechanism, city gas companies must obtain the government's approval when they wish to alter the price being charged to consumers. In addition to trying to maintain gas prices at levels competitive to prices of other fuels, the government also gives a price reduction for gas used to run air conditioners in commercial buildings to help mitigate electricity peak loads. Large industrial consumers are often able to negotiate contract prices that are lower than the government posted price.

In practice, all companies charge the same rate for selling city gas. As a result, some of the smaller companies which do not have the economies of scale that the larger firms have may become marginally profitable or sub-economic due to regional variations in supply conditions. The government's position on the profitability concern is that it is up to the companies to improve their efficiency and thus their profitability. It is widely considered that to increase the number of customers who use town gas would be the best way of achieving this goal and that it would be desirable for the smaller companies to merge.

The price of gas relative to its competing fuels in the residential sector declined significantly since the early 1980's due to successive reductions of gas prices in view of encouraging the use of natural gas.

The government is at present considering the reform of the pricing mechanism for natural gas. One suggestion under review is to include factors such as inflation and exchange rates in the price calculations. Efforts are being made also to accommodate a kind of seasonal discrimination in gas prices for both power generation and town gas. This approach is gathering much attention lately as a possible means to help reduce the difference in demands for natural gas between sea-

sons. If this approach is adopted and proved to be effective, this could relieve the transmission company somewhat from building an excess storage capacity.

V. Policy Implications

The Korean government should continue to encourage the use of gas as an alternative to of anthracite in the domestic and commercial sector and as a mean to reduce the dependency on oil. At the same time, it is necessary for Korea to continue its efforts to diversify sources of LNG importation, as this will contribute to the nation's energy security.

In fact, the government's policy to promote the use of natural gas in Korea, principally by pricing means has led to a vigorous increase in the demand for natural gas. In order to ensure that the imported gas is being used in efficient and effective manner the government is putting increased emphasis on demand-side management. This could take the form of pricing mechanisms which are more strongly based on market pricing as well as the reinforcement of the R&D activities of the Kogas with consideration for more work on efficiency and conservation.

As reviewed, Korean gas industry is in serious need of facility reinforcement. Thus, the nation is pouring a great effort into construction projects for the expansion of its existing capacities, as well as for building new. Effective management is essential for the successful completion of the projects and for stability of energy market in Korea.

Execution of a successful demand management program could slow down the rate of growth in demand, thereby delaying the time when it is necessary to construct additional LNG receiving facilities and to contract for additional LNG supplies. This could free up capital for other natural gas infrastructure projects. Efforts are being made as well by Kogas and the government to accommodate a form of seasonal discrimination in domestic gas prices for both Kepco and city gas distribution companies. This approach is gathering much attention lately as a possible means to help reduce the difference in demands for natural gas between seasons.

The Korean government and Kogas are studying the ways for the reform of pricing mechanism for natural gas. For now, a priority seems to be given to bringing seasonal discrimination into the price setting mechanism for natural gas to ease the peak loading difficulties. Eventually, the pricing tool should also ensure that it more closely reflects a true market price, and in particular allows the Kogas to earn a fair rate of return on its capital investment. To do this, cooperative efforts between Kogas and the electricity company, as well as with the city gas distribution companies should be made.

The Kogas should also put an increased emphasis in its R&D programs on pro-

jects that are aimed at energy conservation and load management, in addition to the technological research on gas production, supply and utilization.

On the international scene, cooperation and dialogue among producing and, consuming transit countries are very important for the growth of international gas markets. The disintegration of the Soviet Union has led to talks of increasing projects for natural gas supplies to Western Europe.

Continued improvements in energy efficiency and energy conservation are expected to be at least, if not more, difficult to achieve in the future than they have been in the past. With regard to energy conservation, it can be said that many of the easy conservation measures have already been undertaken. Nevertheless, technological innovation is still an important driving force in pursuing various energy objectives, such as environmental goals to reduce pollutant emissions, as well as to reduce the overall energy intensity of economic activity around the world. Technology also will be a key factor affecting the structural change among the world's economies moving away from energy-intensive heavy manufacturing, toward less energy-intensive services and high-technology industries.

Overall, the prospects remain bright despite some of the practical concerns that have been raised. However, this prospect can only be guaranteed when there is successful management of national economic activities and energy markets. These efforts have to be made in a way that is both commercially prudent in the short-term and economically viable to maintain the impetus built up successfully during the 1990s for developing the new gas project that are needed in the early years post 2000.

Of course this is not an easy task. Although growth is unlikely to stall, market conditions before 2000 could be frustrated by short term LNG oversupply. These circumstances will certainly test the growth plans of the gas industry, and all the more so if a sustainable increase in oil prices in the foreseeable future is not going to be materialized.

VI. Conclusion

This paper has focused on several issues that the Korea gas industry faces as it enters the third milestone. With enormous growth potential, Korean gas industry is having opportunities as well as facing challenges. As the market expands, the industry will have to invite more business entities to participate in the supply process of natural gas, offering with good perspectives of attractive economic outcomes.

This, however, will require all participating players to exert to secure import sources, to boost the supply capacity and to draw finance for capital investment,

without which the industry cannot become capable of handling the increased gas supplies. These efforts are required all along the gas chain from field production to consumer, including LNG liquefaction, shipping, pipeline transmission and storage facilities.

There may also arrive many other difficulties on the road to secure stable supply of natural gas in Korea for the future, such as those concerning supply sources, financing, environmental, and legal aspects. The Korean gas industry is believed to have the capability to meet the challenge, and to go forward by cultivating an expanded yet effective market. But on the road to achieve this, all players and participants in Korean gas industry should exert their best efforts to solve problems on a rational and cooperative ground.

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